according to him, a circle round each segment; by reduction, the more usual number, eight, has been brought about. He refers to *Anisochæta* (which, by-the-by, we find on turning to the systematic part of the work, only a synonym for *Megascolex* sp.), a perichæte with only eight bristles on the anterior segments, as a step in this process, which in certain normal octochætous forms, may go so far as to cause the entire disappearance of bristles from the anterior segments. Since the monograph was in press, Prof. Bourne has published (*Quart. Journ. Micr. Sc.* xxxvi.) an account of the development of the bristles in the embryo of *Perichæta*, which rather tends to support the view, that the primitive number was eight, and that the perichætous condition is due to the appearance of additional bristles; and the fact that a circle of bristles occurs in another family of earthworms, as well as in certain Polychætes, also makes against Beddard's views.

Another phylogenetic point of special interest is that of the nephridia. Beddard and others have held that the "plectonephric" or "micronephric" condition is antecedent to the "meganephric"; but the ontogeny of three distinct genera contradicts this view, which Beddard, evidently with reluctance, now gives up. I quite agree with him and others, that my group "Plectonephrica" is artificial.

But while regarding the perichætous condition as archaic amongst earthworms, he places at the base of the whole Oligochæte tree (p. 173) a genus, *Phreoryctes*, in which there are usually only *four* bristles in each segment. Mr. Beddard recognises the difficulty of his position, but does not meet it in a very convincing manner. The facts of the geographical distribution of the earthworms are of great general importance, for the worms and their cocoons will not withstand prolonged immersion in sea-water, and modes of transference are few; the cocoons, being buried deep in the earth, are not likely to be carried on the feet of birds. "The characteristic earthworms of New Zealand are Acanthodrilids; the same family is equally characteristic of Patagonia and the adjacent islands; the only known earthworms from Marion and Kerguelen islands belong to the genus *Acanthodrilus*. These facts seem to me to be sufficiently important to require the formation of an antarctic region circumpolar in extent"—though it would not necessarily include the Cape. Australia is more closely allied to the oriental region (p. 154) than one would have suspected.

We may heartily congratulate Mr. Beddard on this able and readable monograph which he has found time to write, in addition to publishing many papers on other subjects in connection with his work as Prosector to the Zoological Society; and we may also offer our thanks to the Clarendon Press for undertaking this work. The book consists of 725 quarto pages of text, together with 85 pages of bibliography, and a full index (from which, however, we miss *Anteus*); there are five lithographed plates, and numerous illustrations in the text; it is well printed, with wide margins, and simply but effectively bound. But, while offering our congratulations, we must also record a grumble; for there are one or two omissions which detract from the usefulness of the work, from a systematist's point of view. (1) A tabular statement of the classification adopted, would have rendered his views more clearly and more readily than having to weed it out of the text; (2) a synopsis of differential family characters in tabular form, such as we find in the recent Catalogues of the British Museum, would enable one to refer an earthworm to its family with comparative ease. Tables of generic characters there frequently are; but they are often so ill-arranged as to be of comparatively little use. Some of these tables extend across two entire pages of fifty lines or more, and it is extremely difficult for the eye to follow these lines across the wide margins of the two pages (pp. 532-533), especially when, as in p. 632 of my copy, the pages are so bound that the lines do not correspond. This matter might have been so easily remedied by numbering the lines on each page.

Lists of the genera recognised as good, are usually given after the discussion of the family characters; but in some cases, as in Perichætidæ, the list does not appear.

The number of plates seems very inadequate to the text, and it is not evident what plan has been followed in selecting the species figured to illustrate the vascular system, for example; for not one of the figures pretends to give a complete plan of the system, and the chief types even are not represented. Plate v. will remain a mystery to many readers. The diagrams of the reproductive organs, which are on the plan adopted by me in my "Attempt to Classify Earthworms," might have been, with advantage, increased in number so as to include every family.

Such interesting matters as the encysted *Æolosom*, and the peculiarly modified genital setæ of Acanthodrilids, might well have been illustrated.

In such an extensive work as this, misprints and smaller errors can scarcely be excluded, but they are very rare; nevertheless, we think that all measurements should have been given in the metrical system. Here and there one finds "inches" cropping up (*Geoscolex maximus*); and sometimes, where the original measurements were in inches, the transformation to millimetres has been worked out wrongly (*Plagiochæta*).

But with all its faults, the monograph redounds to the credit both of the author and the publishers, and is a most welcome addition to our zoological standard works.

W. B. Benham.

DYNAMICS.

Dynamics. By P. G. Tait, M.A., Sec. R.S.E. Pp. 361. (London: Adam and Charles Black, 1895.)

THE main substance of Prof. Tait's present work has, for the past twelve years, been accessible to any one who cared to be at the trouble of consulting the cumbrous volumes of the "Encyclopædia Britannica," but we are glad that the author has at last been induced to issue his article on "Mechanics" in the form of a compact and handy octavo volume. This will be a useful addition to the library of every teacher who has to lecture to advanced classes, but the very encyclopædic treatment of the subject makes it rather hard to judge how far Prof. Tait's work meets the requirements of students. The author himself says in the preface that "in teaching, I have found it advantageous to supplement the work at each stage by additional examples of the processes given in the text; as well as by references to special books in which particular questions are examined with greater detail." Considered as a synopsis of the principles of statics, particle and rigid dynamics, hydrodynamics, and even portions of elasticity, the book may safely be recommended either to mathematical students, or to such students of physics or engineering as have undergone the necessary preliminary grounding in higher analytical methods.

In its new form, Prof. Tait's "Dynamics" might be not inaptly described as a "Thomson and Tait for Beginners," and in scope and plan it is not very different from Ziwet's American treatise on "Theoretical Mechanics." It opens with a short introductory chapter on Newton's laws, followed in chapter ii. by over 80 pages devoted to pure kinematics, under which heading the analysis of strain receives a fair share of attention. Chapter iii. opens with a few further definitions relating to the laws of motion, chiefly extracted from "Thomson and Tait," followed by an outline of statics of a particle and the theory of attractions, including Green's theorem and the method of electrical images; the whole being condensed into 36 pages. Chapters iv. and v. deal with particle kinetics, and include 14 pages on the principle of least and varying action, and 6 pages on Lagrange's generalised equations. Statics and kinetics of a rigid body follow next, then a short chapter on the dynamics of a chain, in which vibrations of strings occupy only 7 pages. After this comes a still shorter chapter containing a few of the simpler applications of the theory of elasticity. In chapter x. the fundamental equations of hydrodynamics are disposed of in 25 pages, and are followed by a chapter on waves, based on Prof. Tait's "Encyclopædia" article on the subject. The author concludes with a short philosophical discussion on the "objectivity of force."

Unlike the ordinary run of text-books, this one contains no collections of examples, but in most of the worked-out problems, only the main results are stated, so that the reader will find plenty of work to do in filling up the gaps. Perhaps this plan will afford as good or better training than the usual routine of "bookwork and riders." There is a further advantage in the elimination of unnecessary formulæ from the text. The judicious use of small type has also done much in making the mathematical portion appear less formidable, and the use of dark type has been avoided by adopting the method of indention.

A reviewer naturally turns his attention sooner or later to the sections which deal with the laws of motion, and these cannot be said to be above criticism. The recognition of Newton's scholium to the third law as a separate dynamical principle is good, but we should have been glad to have seen greater definiteness in dealing with the second law. We all know that "quantity of motion" is to be interpreted as momentum, but Newton makes no mention of *time* in his statement, and modern text-book writers have remedied the deficiency by restating the second law in the following three different ways:

(1) *Rate of* change of momentum is proportional to the force.

(2) Change of momentum *in a given time* is proportional to the force. (In other words, change of momentum varies as the force when the time is kept constant; the fact that it varies as the time when the force is kept constant, being regarded as too obvious to require stating as a law.)

(3) Change of momentum is proportional to the *impulse* of the force, *impulse* being defined as the time-integral of a force.

Now, Prof. Tait appears to regard the law from the second standpoint on page 8, and from the first on page 100, and yet reference to the "Principia" suggests that the third interpretation is the most strictly Newtonian, since Newton evidently regarded *force* as capable either of being impressed gradually, or of being concentrated about a single instant of time. A statement of Prof. Tait's real views would have been far more acceptable than the series of definitions of "change of momentum," "rate of change of momentum," "rate of change of kinetic energy," "space-rate of change of it," with which chapter iii. opens. If a *rate* had been defined generally, these definitions would be superfluous.

In § 118 we are told that "the second law gives us the means of measuring force, and also of measuring the mass of a body." We had always thought (and still think) that the *third* law is required before *both* force and mass can be measured. For in comparing two forces, Prof. Tait supposes them applied in turn to the same body. But this test affords no criterion of the equality of two forces when applied to different bodies, as they have to be in comparing the masses of the bodies. If we assume an independent definition of equal forces (as, for instance, in Prof. Tait's illustration on p. 111, where he assumes that the same locomotive exerts approximately the same pull on two different trains), the second law, of course, affords a means of comparing two masses, but not otherwise.

We are sorry that Prof. Tait has not altogether banished from his book that highly misleading and artificial phraseology of "a point having several simultaneous velocities" in connection with the parallelogram law (§ 117). Combined with the definition of *velocity* as "rate of change of position," this always *seems* to suggest the (absurd) notion that the point moves into, and therefore occupies, different positions at the same instant. All that the parallelogram of velocities really proves, and what Prof. Tait proves in §§ 30, 31, is that if the velocity of A relative to B and the velocity of B relative to C are represented by two sides of a parallelogram, the diagonal represents the velocity of A relative to C. In passing from this to the parallelogram of forces, the discontinuity of reasoning could perhaps be overcome by a reference to Newton's commentary on his second law, which states that the effect of several forces is the same whether they be impressed simultaneously or successively.

In § 108 the author defines as "the 'component' of a force in any direction" what is now, with great advantage, usually called the *resolved part* of the force in that direction.

We should also like to see the use of the word "stress" avoided in connection with Newton's third law (§§ 174, 352), until some definite understanding has been arrived at as to whether the term is to signify a force, or (like pressure) a quantity of the dimensions of force divided by area; but, after all, we have had to put up with ambiguities of this kind for so long, that the matter is of no great consequence to the class of readers for whom Prof. Tait's useful little book is intended. G. H. B.

OUR BOOK SHELF.

The People of the Moon. By Tremlett Carter. Pp. 402. (London: The *Electrician* Printing and Publishing Co., Ltd., 1895.)

This remarkable book bears upon every page evidence of scientific knowledge and vivid imagination. It is not simply a story of a journey to our satellite—that idea has been worn to threads since Jules Verne used it for the ground-plan of his novel—but purports to be a translation of a volume written by a lunar inhabitant, and sent to the earth. More than one ingenious individual has sapiently suggested that the side of the moon remote from us is inhabited; and as we are not likely to obtain any information on the matter, every one is free to indulge in that belief. The idea that there are living beings in the moon's interior, is of a similar harmless character, and the author of this book has made the most of it.

Down in the interior of the moon, and near the centre, dwelt a race of people—the Sarâva—who believed that the universe was an illimitable extent of solid rock, honeycombed throughout with endless tunnels and caverns. But a man arose—a lunar Copernicus—who propounded the doctrine that the place which the Sarâva occupied was merely a lump of cavern-hollowed rock suspended in an infinite vacant space. Urged by a vision, a Prince of the Sarâva sets out with two companions in the hope of reaching the surface, and their expedition is successful. With the adventures of the explorers, we have nothing to do, nor is it for us to analyse the sentimental undercurrent. The attractive parts of the story, from the scientific point of view, are those which show the author's acquaintance with electromagnetic waves and the ether. He makes the Sarâva possess machines to etherealise matter, so that by having two powerful electromagnetic foci at any distance apart, it was possible to transmit objects or people from one to the other with the velocity of light; the object being etherealised at one focus, projected to the other, and then by a similar series of electromagnetic waves converted into its material state. Having reached such a high state of knowledge of the ether, it is hardly necessary to say that the Sarâva could see and speak with one another at a distance, without the necessity of connecting wires, and had also managed to tap the ether and use its terrific energies in destructive weapons. How very intelligently, and with what regard to known facts these imaginary machines are constructed, can only be appreciated by a perusal of the book. We congratulate the author on the skilful and original way in which he has handled an old subject.

Frail Children of the Air. Excursions into the World of Butterflies. By Samuel Hubbard Scudder. Pp. 279. Nine plain plates. (Boston and New York: Houghton, Mifflin, and Co. London: Gay and Bird, 1895.)

It might be supposed from the title of this book, that it was wholly popular, and that entomologists would find little to attract their attention in it; but this would be a great error, for it is really a collection of thirty-one philosophical essays on butterfly and caterpillar life, reprinted, with additions and modifications, from Dr. Scudder's great work on the "Butterflies of New England." Many subjects of great interest and importance are touched upon, relative to the modes of protection of butterflies in all their stages: fossil butterflies; the origin of the present butterfly fauna of North America; the habits of butterflies, caterpillars, &c. One of the most interesting chapters is, perhaps, that relating to the butterfly fauna of the White Mountains of New Hampshire, where butterflies appear to swarm to an extent which the richest localities in Europe could perhaps hardly parallel in number of individuals. Dr. Scudder does not confine his remarks to American species, however, but has also looked up the European literature bearing on his subject very thoroughly, as, indeed, was only to be expected from an entomologist of his industry and energy. Here and there, however, we may detect a casual oversight, as where *Iphiclides podalirius*, L., is spoken of as "confined to the Mediterranean region" (p. 247), when it is really found throughout the greater part of Central Europe as well. Occasionally, too, Dr. Scudder's information can be supplemented, as when in speaking of ants attending the larvæ of *Lycænidæ*, he omits the instances which have been recorded of some Australian species (*Hypochrysops delicia*, Hewitson, and *Ialmenus evagoras*, Donovan, &c., see Anderson and Spry's "Victorian Butterflies," pp. 94, 98, 99). Incidentally various subjects of more general interest are remarked upon, as where Dr. Scudder agrees with Desor (p. 250) in attributing the greater intensity, both of butterfly and of human life in America, as compared to Europe, to the much greater vicissitudes of climate in the former country; or when, in more than one passage, he agrees with Wallace and others, among our deeper-thinking naturalists, that the workings of natural selection are incomprehensible unless we regard them as guided by a controlling intelligence. W. F. K.

The Story of the Earth in Past Ages. By Prof. H. G. Seeley, F.R.S. Pp. 196. (London: George Newnes, Ltd., 1895.)

Prof. Seeley tells the geological story of the earth in an orderly, though not strikingly luminous, manner. Beginning with evidence of the earth's internal heat, he passes to the materials of mountain chains, and then to the consideration of volcanic rocks. With reference to the latter section, it seems to us that his descriptions of the compositions of rhyolites, trachytes, andesites, and basalts are more suitable for a text-book than for a book intended for popular reading. In fact, Prof. Seeley has too exalted an idea of the knowledge of the general public, who, we are afraid, will not be able to understand a large part of his little book. Few of his unscientific readers will have any idea conveyed to them by remarks such as follow: "The bivalve shells are usually species of *Cyclas*, or *Unio*, or *Anodonta*. The univalve shells are either the pond shells *Planorbis*, *Paludina*, and *Limnæa*, or such river shells as *Neritina*, and the fresh-water limpet." Similar instances of the use of technical nomenclature without explanation could be quoted from almost every chapter in the book.

The materials of stratified rocks form the subject of the fourth chapter, and then, after short descriptions of the succession of strata, the origin of stratigraphical geology, and fossils, the formations are treated in order, from the Archæan rocks to glacial deposits and gravel beds. Within the compass of less than two hundred small pages, it has only been possible for Prof. Seeley to indicate a few of the features of the different rocks. Thus, the chapter on Archæan rocks consists of three small pages, and would only fill about a column of Nature, and there are other chapters just as scanty. Most of the figures are very badly reproduced, and there is no index; so that, altogether, we do not regard the book as a very satisfactory one.